Ecological Condition of National Parks: Enabling Decision Support through Monitoring, Analysis and Forecasting

NASA Decision-support through Earth-Sun Research Results

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Abstract

Most park units are subjected to rapid changes in and near park boundaries that affect the area or quality of critical habitats, modify water quality, quantity or flow, and alter natural disturbance regimes. These factors are critical to understanding key threats to park ecosystems and to evaluating appropriate responses to change. This project will identify NASA Earth-Sun Science products that are useful to park monitoring and a park centered ecosystem appropriate for landscape scale analyses and monitoring. It will add value to NASA products through analysis and forecasting and provide a means of integrating these techniques and information into the NPS natural resource science culture. Integration will be achieved in part through the production of a suite of standard operating procedures and recommendations which can be executed by park personnel in the future. Research scientists are working closely with the NPS Inventory and Monitoring program and are examining YELL, ROMN, YOSE and DEWA as pilot sites.

Project Approach

Introduction

Most park units are subjected to rapid changes in and near their borders that are affecting park ecology. These landscape-scale factors are critical for understanding key threats to park ecosystems and developing appropriate responses to change. It is expected that the better NPS managers understand and can anticipate threats, the better they can protect resources and plan for change. This project aims to provide the NPS with additional tools and expertise to evaluate and anticipate ecosystem scale change. The project team is partnered with NPS Inventory and Monitoring Program (I&M) staff to engage in capacity building and leverage the I&M framework for ecosystem monitoring and decision-support that has already been developed. This project will be considered a success if aspects of its results and deliverables are incorporated into the NPS natural resource science culture and continue to be used in the future.

Project Goal

Integrate the routine acquisition and analysis of NASA products and other data sources into I&M and use these products to evaluate and forecast ecological condition of US National Parks.

Project Objectives

- Identify NASA and other products (indicators) useful to park monitoring and identify the boundaries of the park centered ecosystems appropriate for research and monitoring
- Add value to these data sets through analysis and forecasting to better understand change
- Deliver these products and a means to integrate them into the NPS I&M decision support framework

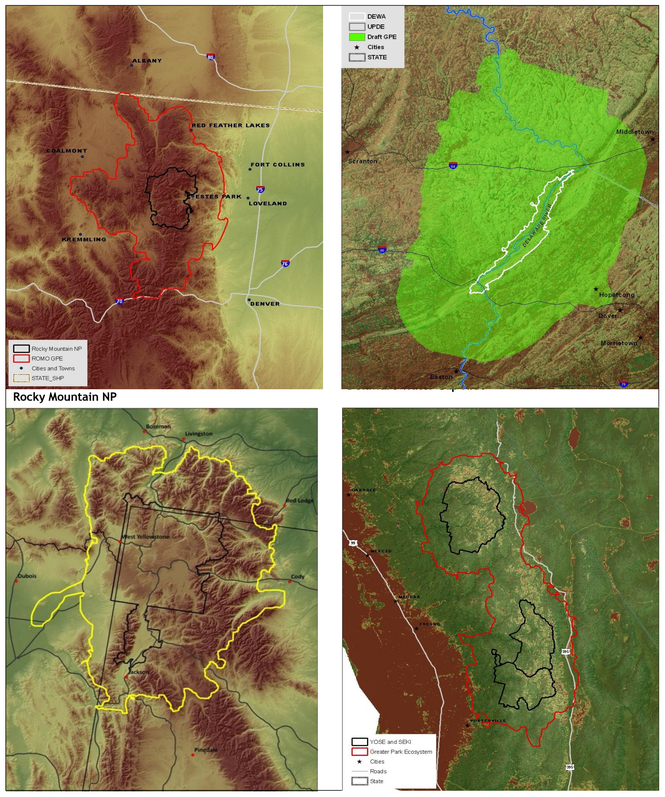
Results and Products

Project scientists are developing tools and analyses based on their expertise and NPS needs. Analysis results include hind and forecast models, and a comprehensive report for each study park which interprets observed and expected change. Other deliverable products include tools and methods that NPS staff can incorporate into their own work. Finally, this project will provide training to its I&M partners in the use of these tools and methods through workshops and other interaction. This project represents a tremendous opportunity for NASA to demonstrate the utility of its products and for the NPS to enhance its ecosystem scale analysis capabilities.

Study Sites

We aim to demonstrate our approach by applying methods at four focal park sites, depicted below along with their draft park centered ecosystem boundaries as delineated by this project. Focal parks include:

1. Yellowstone and Grand Teton National Parks (YELL, GRTE)
2. Yosemite and Sequoia and Kings Canyon National Parks (YOSE, SEKI)
3. Rocky Mountain National Park (ROMO)
4. Delaware Water Gap National Recreation Area (DEWA)



Rocky Mountain NP

Yellowstone and Grand Teton NPs

Yosemite and Sequoia and Kings Canyon NPs

Figure 1. Project study sites

Indicators

Project scientists worked closely with I&M and park staff to identify a short list of indicators for each study park. Below are listed the indicators identified by this project and for which parks they will be developed.
(* = all parks; D = DEWA; R = ROMO; S = YOSE/SEKI; Y = YELL/GRTE):

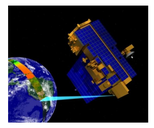
*Greater park ecosystems
*Major habitat type
*Land use
Impervious surface change - D
Stream health - D
*Visitorshed demography
Phenology - S, Y
*Housing density change
*Landscape Fragmentation
Soil moisture - S, Y
Climate - D, S, Y
*Major ecosystem Type
Fire effects - S, Y
*Human Demography
Primary productivity - D, S, Y
Soil Moisture - D, S, Y

Analysis and Forecasting

Several indicators are being modeled for past, present and future conditions to assess change. The following table shows indicators and the timeframes for which they will be modeled:

Hindcast		Nowcast		Forecast
1950	2005	2005		2050
TOPS (Gridded)		Climate		Downscaled-GCMs (point based)
		NPP/GPP		
		Snow		
		Phenology		
		Disturbance		
SERGM		Home density		SERGM
		Impervious		SLEUTH
		Visitorsheds		
Altered by land use		Landscape spatial pattern Connectivity Biodiversity		Altered by land use
Data/Models	Theme	Data/Products	Theme	Data/Models

Table 1. Timeline for project modeling products



Example Results

Land Use Change in the Delaware River Basin

Residential development upstream of park boundaries is a major concern for NPS managers in the Upper Delaware River Basin because of its ability to affect stream health in protected park waterways. Depicted below are the results of an urban development model in the Upper Delaware River Basin produced by this project that will help NPS managers anticipate likely future change that will likely affect their park ecology.

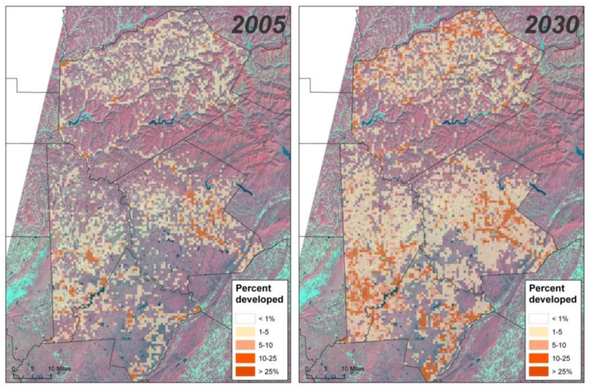


Figure 2. Forecasted change in percent developed from 2005 to 2030 in the Upper Delaware River basin

Connectivity Among Forested Habitat in the U.S. West

Future change may bring with it the need for species to either adapt to new conditions, move to new locations, or face the possibility of extinction. For this reason there's intense interest in discovering and protecting long-distance migration and dispersal corridors across the country and around the world. The figure below shows a graph theory analysis of forested habitat patches in the Western U.S. and the critical backbone of connectivity among them. The inset to the right shows the southern rocky mountain region where ROMO sits among some of the habitat patches of highest importance.

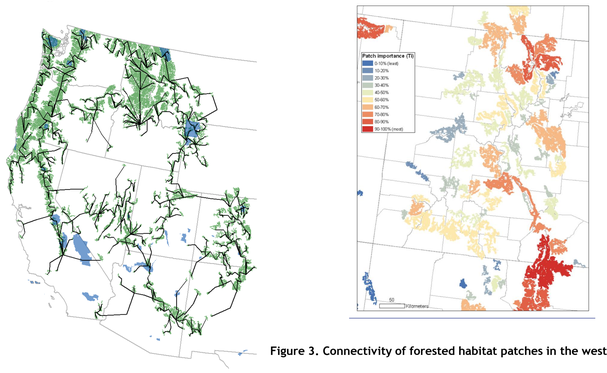


Figure 3. Connectivity of forested habitat patches in the western US

Final Products and Deliverables

The final products and deliverables to the NPS from this project include the following:

1. Indicator data
   - Layers or metrics
2. Analyses and condition assessments
   - Park specific reports which synthesize all project information into a comprehensive storyline of change past to present and expected change into the future along with potential consequences for park ecology
3. Tools and standard operating procedures s (SOPs) so that I&M or park staff can replicate or modify analyses and processes employed by this project
4. Training for NPS staff who are interested in using these methods at their park or network site

Standard Operating Procedures (SOPs)

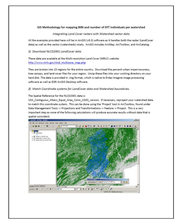


Figure 4. Example SOP

The NPS I&M program has emphasized the utility of standard operating procedures, or SOPs, for the replication of measurements, analyses and other repeatable steps in an ecological monitoring program. This project adopts this framework and is developing a suite of SOPs for transfer to the NPS. SOPs produced by this project may reference peer-reviewed publications, tools, models or other publically available resources. Project team-members are currently working with NPS staff to ensure that SOPs developed by this project are usable and useful. The figure to the left is a snapshot of an SOP to predict and map stream biota richness based on landscape factors like land cover and use.

Tools: ESRI Model Builder for Analysis

Many NPS staff are both familiar and skilled in the use of ESRI GIS software products. This project uses ESRI's Model Builder to develop and transfer a number of tools to the NPS. Below is a screen capture of a set of processing steps used in a tool to model landscape connectivity, similar to what produced the results presented in the second example to the left.

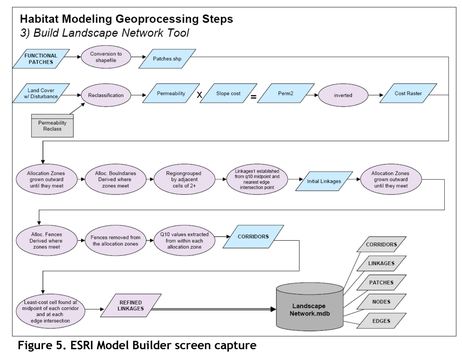


Figure 5. ESRI Model Builder screen capture

Tools: Ecocast Data Gateway for Visualization and Analysis

The Ecocast data gateway is a repository, visualization, analysis and query tool that supports satellite and time-series data as well as maps of model results for parks. It is accessible via any computer with an internet connection. You can see a working version of Ecocast set up on a computer elsewhere in this poster session.

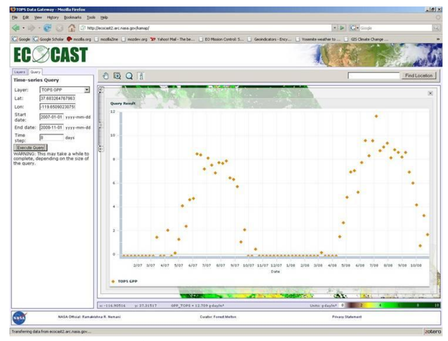


Figure 6. Draft ecocast data gateway screen capture

Project Status and Future

This project is entering its last of three years. The third year will be spent developing and transferring tools and products to the NPS. It is our hope that this project demonstrates the utility of NASA Earth-Sun Research Results to NPS science and decision-making. In developing an approach, along with contacts and a model for interaction, this project has paved the way for future projects to be more efficient and effective. We would like to expand this approach to all NPS units and I&M networks that have an interest in a partnership to improve their understanding of ecosystem scale processes and enhance their ability to study and monitor them.

Acknowledgements

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